Are Defaults Correlated? An Empirical Study

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Abstract

This paper investigates default correlations. Both inter-industry default correlations and intra-industry default correlations are examined using historical default rates by industry. The state of the economy, i.e. expansionary and recessionary periods, is incorporated in the study to evaluate their impact on default correlations. Specifically, macro-economic variables are linked to default rates per industry to investigate default correlation cyclicality. Finally, the empirical evidence of the relationship between equity correlation and default correlation is studied using observable industry equity index return correlation as a proxy.

Key words: Inter-industry default correlations, Intra-industry default correlations, Default correlation cyclicality.

JEL classification: G14, G33.

Introduction

The fortunes of individual companies are linked together via similar economic conditions and via industry-specific criteria. As a result, the default events of companies are often correlated. These correlations are crucial in credit analysis, derivatives pricing, and especially in risk management. The importance of default correlation analysis has been widely recognized by the financial industry in recent years, see for example Zhou (2001) or the BIS (2004).

Analytically, the joint probability of two entities A and B defaulting, $\lambda(A \cap B)$, is simply the multiplication of the individual default probabilities $\lambda(A)$, $\lambda(B)$, if the entities' default is not correlated. Hence $\lambda(A \cap B) = \lambda(A) \text{ x } \lambda(B)$. If the default probabilities of entities A and B are correlated, in practice equation (1) is often applied.

$$\lambda(A \cap B) = \rho(\lambda(A),\lambda(B)) \sqrt{[\lambda(A) - \lambda(A^2)][\lambda(B) - \lambda(B^2)]} + [\lambda(A)\ \lambda(B)], \quad (1)$$

where -1≤ $\rho(\lambda(A),(\lambda(B))$. If the two entities are publicly traded companies, the coefficient ρ is often derived from equity correlation. However, in this study, we find no evidence for a relationship between equity correlation and default correlation (see section IV 4).

From equation (1) we can see that for a default correlation $\rho(\lambda(A), \lambda(B))$ of zero, the joint default probability $\lambda(A \cap B)$ is indeed the product of the individual default probabilities of $\lambda(A)$ and $\lambda(B)$ as stated above, $\lambda(A \cap B) = \lambda(A) \text{ x } \lambda(B)$.

In equation (1) a rather simple correlation measure is applied. The correlation between a) a variable that takes the value 1 if company A defaults and 0 otherwise, and b) a variable that takes the value 1 if company B defaults and 0 otherwise, is modeled.

The rather simple correlation measure in equation (1) is often applied by rating agencies.

A more complex correlation measure that has gained market popularity in the recent past is the Copula model. Here a joint distribution function is formed from marginal functions, incorporating the dependence structure. For a good introduction to copulas see Romano (2000) and Li (2000).

The purpose of this study is not to develop analytical models to estimate default correlation, but rather to present findings about empirically observed behavior of default correlation based on historical default data. To capture the important dependence feature of default correlation on the prevailing economic environment and industry-specific environment, this study incorporates two major factors, – industry and business cycle, – to analyze correlation matrices for companies in different industry sectors. To respond to the emphasis of the New Capital Accords of Basel Committee on correctly capturing the cyclicality of risk by credit models due to the well known "credit cycles", this paper specifically examines the extent to which macro-economic factors drive industry defaults. In addition, this paper will provide some empirical evidence of the relationship between default correlation and equity correlation due to an extensive application of the approach to incorporate equity correlation into the estimation of default correlation descending from Merton's structural model.

Specifically, the objectives of this study are:

1. To find inter-industry default correlations, i.e. between companies in different industry sectors. The inter-industry default correlations are investigated in a general economic environment, in expansionary periods and in recessionary periods.
2. To find intra-industry default correlations, i.e. between companies within an industry sector via an autocorrelation analysis.
3. To capture the effect of three macro-economic factors i.e. a) the change of the S&P 500, b) the change of the 10-year Treasury Yield, and c) the change of the GDP on default rates.
4. To find empirical evidence of the relationship between equity correlation and default correlation.

This paper is organized as follows: Section II entails the Literature Review. Section III describes the Methodology. Section IV gives the results of the empirical analysis. Section V summarizes and concludes. The appendix displays the detailed numerical results of the analyses.

Literature Review

Currently, two main approaches to model default correlations exist. The first approach uses historical data, which is based on a statistical analysis of the joint behavior of migrations and defaults directly from historical data, without relying on a specific model driving transitions. Lucas (1995), J.P. Morgan's CreditMetrics (1997), Lando (1998), Duffie and Singleton (1999) and Bahar and Nagpal (2001) have developed models and illustrated their applications in estimating default correlation by using this *reduced form* approach. The shortcomings of this approach are well known. First, due to the rare occurrence of bond defaults, there are usually not enough time-series data available to accurately estimate default correlation. Second, the approach does not use firm-specific information and, therefore, cannot capture the economic reasons driving default. Third, default correlation is time-varying, so past history may not reflect the current reality. Fourth, due to the fact that default is a zero/one event, the direct correlation estimation using historical data is not very informative because for all non-defaulting firms in a sample, the realizations of the default variables are uniformly zero, and thus the sample default correlation is also zero (Jarrow & Deventer, 2004).

The second, *structural approach*, models default correlation utilizing a particular theoretical structure of the default process based on the seminal Merton's (1974) model. His approach to default considers that equity holders have the option to sell the firm's assets rather than to repay the debt if the asset value drops below the debt value. Given two firms' asset values, their variance/covariance matrix, and their liability structures, the joint default probability of them is constructed on the basis of their asset correlation and their expected default frequency. In Merton's (1974) framework, the assumption that default can only occur at the maturity of a bond is unrealistic. This restrictive assumption is relaxed in first-passage-time models of default risk. Black and Cox (1976), Longstaff and Schwartsz (1995), Leland and Toft (1996), Leland (1998), Hull and White (2001), Zhou (2001), and many other researchers have provided analytical models for calculating joint default probability and default correlations in this approach. A major extension of this approach is to import of the above mentioned copula function in conjunction with the structural model to estimate default correlation, which has gained recognition and popularity in the industry (see David X. Li, 2000). The main drawback of this approach lies in the fact that it requires assumptions about the relationship between asset prices and default. Equity prices are often used as a proxy to estimate asset correlations given that asset values are not directly observable. One commonly employed method is the identification of a benchmark for the purpose of developing asset return correlations and then mapping these into default correlations. However, there is no empirical evidence of a direct relationship between equity correlation and default correlation. Also, this approach is difficult to apply within a retail context as there is often no asset price observable for an individual borrower. In addition, default correlations estimated from this approach are restricted to time frames, typically one year, as the default probabilities may change in the next year.

Methodology

Data

This study uses Standard & Poor's historical annual default rates by industry from 1981 to 2003, obtained from its CreditPro 6.6 database, which involves 10,438 companies that were first rated by Standard & Poor's as of Dec. 31, 1980, or that were first rated between Dec. 31, 1980 and Dec. 31, 2003 (see Table 1). There are 13 sector categorizations in this study: Aerospace/automotive/capital goods/metal (abbreviated 'Auto'), Consumer/service sector ('Cons'), Energy and natural resources ('Ener'), Financial Institutions ('Fin'), Forest and building products/homebuilders ('Build'), Health care/chemicals ('Chem'), High technology/computers/office equipment ('Hitech'), Insurance ('Insur'), Leisure time/media ('Leis'), Real estate ('Real'), Telecommunications ('Tele'), Transportation ('Trans'), and Utility ('Util'). The analysis excludes public information ratings and ratings based on the guarantee of another company. Structured finance vehicles, public-sector issuers, and sovereign issuers are also excluded from this study.

The historical prices of the indices are downloaded from Yahoo Finance, and the historical GDP data are extracted from the website of the Bureau of Economic Analysis (see Table 2).

The historical prices of S&P industry equity indices are downloaded from Yahoo Finance, and the equity indices returns are then calculated (see Table 3).

Statistical Tools

Simple linear regression analyses are performed to examine inter-industry default correlations i.e. default correlations between companies in different industry sectors (section IV 1).

In addition, an autocorrelation test is run to determine intra-industry default correlations i.e. default correlations between companies within the same industry sector (section IV 2). This study only employs first-order autocorrelation to measure the degree of correlation between adjacent default rates. If autocorrelation is present, a future series of a variable can be successfully predicted using its own recent past values as explanatory variables.

This study (section IV 3) defines three macro-economic variables: a) S&P 500 index, b) 10 year treasury yield index, and c) Gross Domestic Product (GDP) to explain default correlations between firms in different industries and in the same industry. A standard multiple linear regression test is used to explain default rates per industry and default correlations between industries and within industries by these macro-economic variables. The multiple regression equation is:

$$Y_t = \alpha + \beta_1 RSP500_t + \beta_2 RTNX_t + \beta_3 RGDP_t + \epsilon_t, \tag{2}$$

where Y_t = default rate per industry;

$RSP500_t$ = return of the S&P 500 index;

$RTNX_t$ = return of the 10 year treasury yield index;

$RGDP_t$ = return of the gross domestic product.

The same linear correlation test is run to find S&P industry equity index return correlations. The equity return correlation profiles between industries will be compared to the inter-industry default correlations to identify any empirical evidence about the relationship between equity correlations and default correlations (section IV 4).

Results of the Empirical Analysis

1a) Inter-industry Default Correlations for the Average Economic Environment (see Table 4)

Seen from the correlation output, 15 negative correlation coefficients emerged, but these values are overall small and none of them are statistically significant as indicated by the high associated p-values. The remaining 63 values are all positive. The inter-industry default correlation charts (see Figure 1) further illustrate the significant default correlations between industries. The industries that are on average the most positively correlated with other industries are Aerospace/automotive/capital goods/metal ('Auto'), Consumer/service sector ('Cons'), Forest and building products/home builders ('Build'), and Transportation ('Trans'). Additionally, a further examination reveals that the sectors that exhibit high default correlations with other industry sectors also have high default rates (compared to the average, see Table 1). The industries that are on average the lowest correlated with other industries are Energy and natural resources ('Ener'), and Insurance ('Insur'), both of which exhibit no default correlations with others. This can be viewed as an expected result, since these two industries are generally less dependent on the macroeconomic environment and show relatively low return volatility (see Table 3).

1b) Inter-industry Default Correlations for Recessionary Periods (Table 5)

Following the National Bureau of Economic Research (NBER), we will define a recession as a year in which at least one quarter of that year has negative growth. In the sample, five years fall in this category: 1981, 1982, 1990, 1991 and 2001. Table 5 reports the inter-industry default correlations for recession years over the period of 1981-2003. Compared to Table 4, which includes recessionary as well as expansionary periods, fewer negative default correlations are produced in the recessionary period (14 compared to 29). This may be viewed as an expected result, reflecting the fact that austere macroeconomic conditions tend to aggravate positive default correlations between industries. More importantly, the correlation coefficients produced are higher than those under the general economic environment by an average of 0.17.

The industries that are on average the most positively correlated in recessionary periods with other industries are Forest and building products/homebuilders ('Build'), and Transportation ('Trans'). As seen from Table 1 (last column), these two sectors also display high default rates in recessionary periods. The industries that show no default correlation with other industries during recession periods are High technology/computers/office equipment ('Hitech'), and Insurance ('Insur'). This result reinforces the relative independence and low volatility of the Insurance sector (as discussed earlier), and highlights the relatively independent default dynamics and properties of the high technology sector.

Although we find substantially higher values of default correlation in recessions, they present less statistical significance compared to the correlation profile produced for the average economic environment. This phenomenon may be attributed to the small sample size consisting of only five recession years. The sample size plays a critical role in the test of the significance of the correlation coefficient. When the sample size is large enough, correlations can be significantly different from 0 even if the estimated correlations are rather low, and the smaller the sample size is, the less likely the correlation coefficient can be statistically significant even with high values (Defusco & McLeavey, 2001).

1c) Inter-industry Default Correlations for Expansionary Periods (Table 6)

Table 7 reports the default correlations between industries during the 18 expansion years over 1981-2003 (i.e. excluding the recessionary years 1981, 1982, 1990, 1991, 2001). Compared to the overall picture (Table 4), more negative values of correlation (41 compared to 29) are produced. This is again an expected result, since the improving economy tends relax credit correlations and to produce individual growth opportunities. Table 6 also shows slightly lower levels of positive default correlation by an average of 0.016 in comparison with the overall environment (Table 4). This observation is also explained by the exclusion of the default data in the five recession years, which showed a high number of positive correlation coefficients.

During the expansionary years, Transportation ('Trans'), and Forest and building products/home-builders ('Build') are, as in recessionary periods, the industries that are on average the most positively default correlated with other sectors. This fact highlights the general vulnerability of companies within these two industries with respect to default events. As it was the case in recessionary years, in expansionary years the industries that show no default correlation with other industries are High technology/computers/office equipment ('Hitech'), Energy and natural resources ('Ener'), and Insurance ('Insur').

2) Intra-industry Default Correlations for the Average Economic Environment (see Figure 2)

Analyzing autocorrelation for the past 16 periods, the graphical outputs in Figure 2 indicate that autocorrelation is present in 11 out of the 13 sectors, which are Aerospace/automotive/capital goods/metal (abbreviated 'Auto'), Consumer/service sector ('Cons'), Energy and natural resources ('Ener'), Financial Institutions ('Fin'), Forest and building products/homebuilders ('Build'), Health care/chemicals ('Chem'), High technology/computers/office equipment ('Hitech'), Leisure time/media ('Leis'), Real estate ('Real'), Telecommunications ('Tele'), and Transportation ('Trans'). The presence of autocorrelation indicates that the default rates of companies within these industry sectors are linearly associated with their immediate past values with significance. The only two sectors that do not exhibit autocorrelation are Insurance ('Insur') and Utility ('Util'). This result may be seen as expected, given the fact that the businesses of these two industries are relatively stable (see also Table 3), and companies operating within them usually yield individual market power.

As to be expected, from Figure 2 we see that lag one autocorrelation is the most widely observed autocorrelation. (This means that an observation is explained by the one immediately adjacent (prior) to the observed one.) One lag autocorrelation is found in 9 out of the 11 sectors, which overall show autocorrelation. Only Forest and building products/ homebuilders ('Build') (autocorrelation in the 11^{th} lag) as well as High technology/computers/office equipment ('Hitech') (autocorrelation in the 5^{th} lag) do not exhibit autocorrelation in the 1^{st} lag.

Further research in the area of intra-industry default correlation should be done by observing default correlation between individual companies within the sectors.

3) The Impact of Macro-economic Factors on Industry Level Default Rates (see Table 7)

A standard multiple linear regression test is performed to explain historical default probabilities per industry using the relative changes of the three macro-economic variables: a) S&P 500 index, b) 10 year treasury yield index, and c) Gross Domestic Product (GDP) (see equation (2)). Among the 13 industry sectors, the regression models for 4 industries exhibit statistical significance, which are: Consumer/service sector ('Cons'), Forest and building products/homebuilders ('Build'), Telecommunications ('Tele'), and Utility ('Util'). The resultant regression outputs indicate that the relative change of GDP significantly influences the default probabilities of Consumer/service sector ('Cons') at 99% confidence level, and the default probabilities of Forest and building products/homebuilders sector ('Build') at 95% confidence level; the relative changes of S&P 500 index and GDP significantly influence the default probabilities of Telecommunication sector ('Tele') on a 99% level; and the relative change of S&P 500 index significantly influences the default probabilities of the Utility sector ('Util') on a 95% level.

While the economic dependence of the sectors Consumer/Service (Cons'), building products/homebuilders sector ('Build'), as well as Telecommunication sector ('Tele') can be viewed as an expected result, on first sight, the economic dependence of the Utility sector ('Util') seems surprising. However, the Utility sector ('Util') also displays a surprisingly high return volatility (see Table 3). Hence, companies in the above-mentioned 4 industry sectors can be expected to be relatively prone to default under unfavorable macroeconomic conditions.

4) Empirical Evidence of the Relationship between Inter-Industry Equity Correlations and Inter-Industry Default Correlations

As seen from the industry equity index return correlations output (see Table 8), the 8 industries' equity returns are all positively correlated with each other. Compared with the inter-industry default correlations (Table 4), the equity return correlation coefficients are generally higher than the default correlation coefficients, which is consistent with the empirical result of similar studies (see Servigny & Renault, 2002 and Hrvatin & Neugebauer, 2004). Additionally, the inter-industry equity return correlations present much stronger statistical significance than the inter-industry default correlations. Hence, the results cannot support the assumption that inter-industry equity return correlation is a good approximation for inter-industry default correlation. The lack of evidence of a direct relationship between equity correlations and default correlations may alert the use of the analytical assumption that underlies many credit models, and hopefully may encourage further research in this area.

Conclusion / Summary of Results

- Under the general economic environment, the default rates of most industries are positively correlated with each other.
- The industries that have relatively high default rates tend to exhibit high default correlations with other sectors.
- Energy and natural resources ('Ener'), Insurance ('Insur'), and High technology/computers/office equipment ('Hitech') sectors are identified as the industries that are on average the lowest default correlated with other industries.
- Default correlations between industries vary with business cycles. They tend to increase during high default periods (recessions), while tend to decrease during low default periods (expansions).
- Sectors with high return volatility tend to show high dependence to macro economic factors.
- Intra-industry default autocorrelation is observed in 11 out of 13 sectors.
- Lag one autocorrelation is found in 9 out 13 sectors.
- Companies in Consumer/service sector ('Cons'), Forest and building products/homebuilders ('Build'), Telecommunications ('Tele'), and Utility ('Util') sectors are relatively prone to default under an unfavorable macroeconomic environment. Macroeconomic variables significantly influence the default profiles of these 4 industries.
- There was no empirical evidence found of a direct relationship between equity correlation and default correlation.

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Appendix

Table 1

Historical Default Rates by Industry (in %)

Year	Auto	Cons	Ener	Fin	Build	Chem	Hitech	Insur	Leis	Real	Tele	Trans	Util
1981	0	0	0	0	0	0	0	0	0	0	0	1.98	0
1982	1.36	1.69	0.81	0.9	2.78	0	1.52	2.86	2.13	0	0	1.96	0.41
1983	0.47	1.26	2.54	0	0	0	0	4.44	0	0	0	1.92	0
1984	0	0.41	4.76	0	1.41	0	3.03	0	1.56	0	0	1.83	0
1985	1.29	1.18	3.97	0	0	2.27	0	1.59	2.56	0	0	0.93	0
1986	4.76	0.34	9.92	0	1.28	1	3.61	0	0.98	0	0	0.82	0
1987	1.89	1.29	4.46	0	1.12	0.88	0	0	0.75	0	1.3	0	0.37
1988	1.58	1.88	1.98	1.85	1.04	3.39	0	0	3.27	0	1.25	0	0.73
1989	2.49	1.24	0	1.95	0	0	1.06	0.63	6.85	6.67	0	1.59	0
1990	2.12	4.38	0	1.28	8.08	0	4.88	0	9.38	4.35	2.56	5.26	0
1991	2.31	7.22	2.97	1.7	8.05	1.96	2.94	1.97	7.27	5.88	0	5.05	0.69
1992	1.87	3.16	0.94	1.41	1.3	0	4.62	0	1.87	6.25	0	0	0.99
1993	1.77	1	1.68	0.22	0	0	2.86	0	0.83	0	0	0	0
1994	0.42	1.2	0.76	0	1.01	0.64	1.25	0.25	2.9	0	0	1.56	0
1995	0	3.64	0.68	0.29	2.61	1.17	1.14	0.23	1.78	0	0	2.26	0
1996	1	1.83	0.63	0	0	0	0	0	1.97	0	0.97	0	0
1997	0.91	2.39	0	0.35	0	0.48	0.97	0.22	0.44	0	1.71	0.67	0
1998	1.03	3.21	1.45	1.13	1.18	2.17	0	0	2.82	0.76	1.21	1.75	0
1999	4.04	3.23	4.6	0.21	2.07	3.16	1.9	0.87	5.03	0	1.82	4.64	0.2
2000	3.77	5.45	1.68	0.1	3.48	4.62	4.19	0.45	4.08	0	2.79	4.21	0.37
2001	9.21	5.78	1.65	1.29	4.71	4.1	4.73	0	4.8	0	11.11	3.11	0.68
2002	5.56	2.78	3.11	0.63	4.76	1.74	1.79	0.9	6.32	0.54	18.55	6.06	4.45
2003	3.28	2.84	1.1	0.25	1.56	2.34	2.13	0.84	0.57	0	9.88	2.65	1.57
Sum	51.13	57.4	49.69	13.56	46.44	29.92	42.62	15.25	68.16	24.45	53.15	48.25	10.46
Sum recession	15.00	19.07	5.43	5.17	23.62	6.06	14.07	4.83	23.58	10.23	13.67	17.36	1.78

Source: Standard & Poor's CreditPro 6.6 database.

Years in bold are recessionary years

'Auto': Aerospace/automotive/capital goods/metal; 'Cons': Consumer/service sector; 'Ener': Energy and natural resources; 'Fin': Financial institutions; 'Build': Forest and building products/homebuilders; 'Chem': Health care/chemicals; 'Hitech': High technology/computers/office equipment; 'Insur': Insurance; 'Leis': Leisure time/media; 'Real': Real estate; 'Tele': Telecommunications; 'Trans': Transportation; 'Util': Utility

Table 2

Macro-Economic Variables

Date	S&P 500 Index	Return to S&P 500	10-Y Treasury Yield Index	Return to 10-Y Treasury Yield	GDP in billions	Return to GDP
12/31/1980	135.76		12.43		2,789.5	
12/31/1981	122.55	- 0.1024	13.98	0.1175	3,128.4	0.1147
12/31/1982	140.64	0.1377	10.36	0.2997	3,255.0	0.0397
12/31/1983	164.93	0.1593	11.82	0.1318	3,536.7	0.0830
12/31/1984	167.24	0.0139	11.55	0.0231	3,933.2	0.1063
12/31/1985	211.28	0.2338	9.00	0.2495	4,220.3	0.0705
12/31/1986	242.17	0.1365	7.23	0.2190	4,462.8	0.0559
12/31/1987	247.09	0.0201	8.83	0.1999	4,739.5	0.0601
12/31/1988	277.72	0.1169	9.14	0.0345	5,103.8	0.0741
12/31/1989	353.40	0.2410	7.93	0.1420	5,484.4	0.0719
12/31/1990	330.22	- 0.0678	8.08	0.0187	5,803.1	0.0565
12/31/1991	417.09	0.2335	6.71	0.1858	5,995.9	0.0327
12/31/1992	435.71	0.0437	6.70	0.0015	6,337.7	0.0554
12/31/1993	466.45	0.0682	5.78	0.1477	6,657.4	0.0492

Table 2 (continuous)

Date	S&P 500 Index	Return to S&P 500	10-Y Treasury Yield Index	Return to 10-Y Treasury Yield	GDP in billions	Return to GDP
12/31/1994	459.27	0.0155	7.83	0.3036	7,072.2	0.0604
12/31/1995	615.93	0.2935	5.57	0.3406	7,397.7	0.0450
12/31/1996	740.74	0.1845	6.41	0.1405	7,816.9	0.0551
12/31/1997	970.43	0.2701	5.74	0.1104	8,304.3	0.0605
12/31/1998	1229.23	0.2364	4.64	0.2127	8,747.0	0.0519
12/31/1999	1469.25	0.1784	6.43	0.3263	9,268.4	0.0579
12/31/2000	1320.28	- 0.1069	5.11	0.2298	9,817.0	0.0575
12/31/2001	1148.08	- 0.1398	5.03	0.0158	10,100.8	0.0285
12/31/2002	879.82	- 0.2661	3.82	0.2752	10,480.8	0.0369
12/31/2003	1111.92	0.2341	4.26	0.1090	10,987.9	0.0472

Source: http://finance.yahoo.com.

Table 3

Industry Equity Indices Returns and Volatilities*

Date	Energy Index Return	Financials Index Return	Building products Index Return	Health care Index Return	Technology Index Return	Insurance Index Return	Telecommunications Index Return	Utility Index Return
12/4/2001								
1/2/2002	-0.0193	-0.0179	0.0693	-0.0104	0.0136	-0.0357	-0.0849	-0.0613
2/1/2002	0.0387	-0.0161	0.0464	0.0025	-0.1513	0.0240	-0.0666	-0.0270
3/1/2002	0.0643	0.0632	-0.0077	0.0015	0.0600	-0.0004	-0.0218	0.1124
4/1/2002	-0.0524	-0.0284	0.0217	-0.0647	-0.1323	-0.0083	-0.1736	-0.0225
5/1/2002	0.0009	-0.0033	-0.0459	-0.0209	-0.0395	-0.0345	0.0357	-0.0955
6/3/2002	-0.0029	-0.0504	0.0021	-0.0970	-0.1297	-0.0255	-0.1343	-0.0772
7/1/2002	-0.1365	-0.0865	-0.0945	-0.0230	-0.0872	-0.0838	-0.1393	-0.1546
8/1/2002	-0.0044	0.0206	-0.0010	0.0115	-0.0125	-0.0141	-0.0178	0.0325
9/3/2002	-0.0905	-0.1263	-0.1795	-0.0671	-0.1931	-0.1177	-0.1526	-0.1418
10/1/2002	0.0282	0.0843	0.0494	0.0571	0.2012	0.0823	0.2767	-0.0220
11/1/2002	0.0312	0.0386	0.0241	0.0250	0.1555	0.0442	0.1132	0.0201
12/2/2002	-0.0003	-0.0571	0.0128	-0.0373	-0.1560	-0.0734	-0.0793	0.0366
1/2/2003	-0.0263	-0.0191	-0.1184	-0.0050	-0.0171	-0.0326	-0.0724	-0.0339
2/3/2003	0.0149	-0.0333	0.0164	-0.0196	0.0239	-0.0670	-0.0873	-0.0546
3/3/2003	0.0113	-0.0060	0.0097	0.0331	-0.0123	0.0039	-0.0037	0.0450
4/1/2003	-0.0049	0.1138	0.0932	0.0333	0.0863	0.1246	0.0860	0.0811
5/1/2003	0.0780	0.0495	0.1177	0.0166	0.0803	0.0290	0.0649	0.0939
6/2/2003	-0.0111	0.0005	-0.0218	0.0415	-0.0006	-0.0226	0.0352	0.0085
7/1/2003	-0.0255	0.0424	0.0252	-0.0155	0.0537	0.0642	-0.0633	-0.0706
8/1/2003	0.0551	-0.0118	0.0272	-0.0394	0.0552	-0.0318	0.0000	0.0139
9/2/2003	-0.0253	0.0047	0.0082	0.0032	-0.0068	-0.0114	-0.0431	0.0415
10/1/2003	0.0080	0.0641	0.1202	0.0066	0.0782	0.0483	0.0440	0.0080
11/3/2003	-0.0014	-0.0044	0.0074	0.0144	0.0154	-0.0112	-0.0127	-0.0037
12/1/2003	0.1293	0.0458	0.0086	0.0557	0.0260	0.0838	0.0848	0.0623
1/2/2004	0.0124	0.0291	0.0027	0.0268	0.0342	0.0420	0.0363	0.0183
2/2/2004	0.0393	0.0248	0.0410	0.0069	-0.0334	0.0437	0.0196	0.0150
3/1/2004	-0.0068	-0.0119	0.0675	-0.0426	-0.0271	-0.0214	-0.0151	0.0074
4/1/2004	0.0163	-0.0498	-0.0813	0.0301	-0.0480	-0.0061	-0.0058	-0.0400
5/3/2004	0.0010	0.0169	0.0461	-0.0036	0.0480	0.0051	-0.0419	0.0047
6/1/2004	0.0476	0.0024	0.0393	0.0067	-0.0003	0.0018	0.0316	0.0039
Volatility	4.88%	5.01%	6.45%	3.61%	8.94%	5.26%	9.11%	6.25%

Source: The original prices of the industry sectors are downloaded from http://yahoo.finance.com; returns are then calculated.

*Only 8 industry indices are presented here because these are the only industry equity indices that could be found corresponding to the industry sectors discussed in this study. In addition, monthly equity returns of these industry indices are used, due to the fact that all these indices were initially established in late 2001 and the number of annual observations is limited.

Table 4

Inter-Industry Default Correlations under General Economic Environment

Correlations

		Aerospace/a utomotive/ca pital goods/metal	Consumer/s ervice sector	Energy and natural resources	Financial institutions	Forest and building products/ho mebuilders	Health care/che micals	High technology/ computers/ office equ	Insurance	Leisure time/media	Real estate	Telecomm unications	Transport ation	Utility
Aerospace/automotive/c pital goods/metal	Pearson Correlatior	1.000	.457*	.286	.230	.415*	.595**	.539**	-.123	.396	.005	.693**	.424*	.460*
	P-value	.	.028	.186	.290	.049	.003	.008	.575	.061	.982	.000	.044	.027
Consumer/service sectc	Pearson Correlatior	.457*	1.000	-.209	.460*	.783**	.569**	.510*	.023	.599**	.353	.305	.621**	.203
	P-value	.028	.	.339	.027	.000	.005	.013	.915	.003	.098	.157	.002	.353
Energy and natural resources	Pearson Correlatior	.286	-.209	1.000	-.316	-.022	.168	.123	.029	-.130	-.236	-.018	-.018	.042
	P-value	.186	.339	.	.141	.922	.445	.576	.894	.554	.278	.934	.935	.848
Financial institutions	Pearson Correlatior	.230	.460*	-.316	1.000	.426*	.138	.232	-.041	.622**	.713**	.077	.162	.157
	P-value	.290	.027	.141	.	.043	.530	.286	.851	.002	.000	.726	.459	.475
Forest and building products/homebuilders	Pearson Correlatior	.415*	.783**	-.022	.426*	1.000	.279	.595**	.049	.759**	.379	.360	.791**	.328
	P-value	.049	.000	.922	.043	.	.197	.003	.826	.000	.075	.091	.000	.126
Health care/chemicals	Pearson Correlatior	.595**	.569**	.168	.138	.279	1.000	.172	-.097	.257	-.245	.401	.363	.230
	P-value	.003	.005	.445	.530	.197	.	.433	.658	.236	.260	.058	.088	.292
High technology/computers/o	Pearson Correlatior	.539**	.510*	.123	.232	.595**	.172	1.000	-.233	.402	.357	.218	.393	.119
	P-value	.008	.013	.576	.286	.003	.433	.	.284	.057	.095	.318	.063	.588
Insurance	Pearson Correlatior	-.123	.023	.029	-.041	.049	-.097	-.233	1.000	-.044	.001	-.062	.205	.053
	P-value	.575	.915	.894	.851	.826	.658	.284	.	.841	.996	.778	.348	.809
Leisure time/media	Pearson Correlatior	.396	.599**	-.130	.622**	.759**	.257	.402	-.044	1.000	.582**	.286	.705**	.261
	P-value	.061	.003	.554	.002	.000	.236	.057	.841	.	.004	.186	.000	.228
Real estate	Pearson Correlatior	.005	.353	-.236	.713**	.379	-.245	.357	.001	.582**	1.000	-.150	.181	.032
	P-value	.982	.098	.278	.000	.075	.260	.095	.996	.004	.	.494	.410	.885
Telecommunications	Pearson Correlatior	.693**	.305	-.018	.077	.360	.401	.218	-.062	.286	-.150	1.000	.527**	.861**
	P-value	.000	.157	.934	.726	.091	.058	.318	.778	.186	.494	.	.010	.000
Transportation	Pearson Correlatior	.424*	.621**	-.018	.162	.791**	.363	.393	.205	.705**	.181	.527**	1.000	.463*
	P-value	.044	.002	.935	.459	.000	.088	.063	.348	.000	.410	.010	.	.026
Utility	Pearson Correlatior	.460*	.203	.042	.157	.328	.230	.119	.053	.261	.032	.861**	.463*	1.000
	P-value	.027	.353	.848	.475	.126	.292	.588	.809	.228	.885	.000	.026	.

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

The upper number is the Pearson correlation coefficient, which is the multiple R reported in linear regression.
The lower number is the P-value associated with the correlation coefficient.

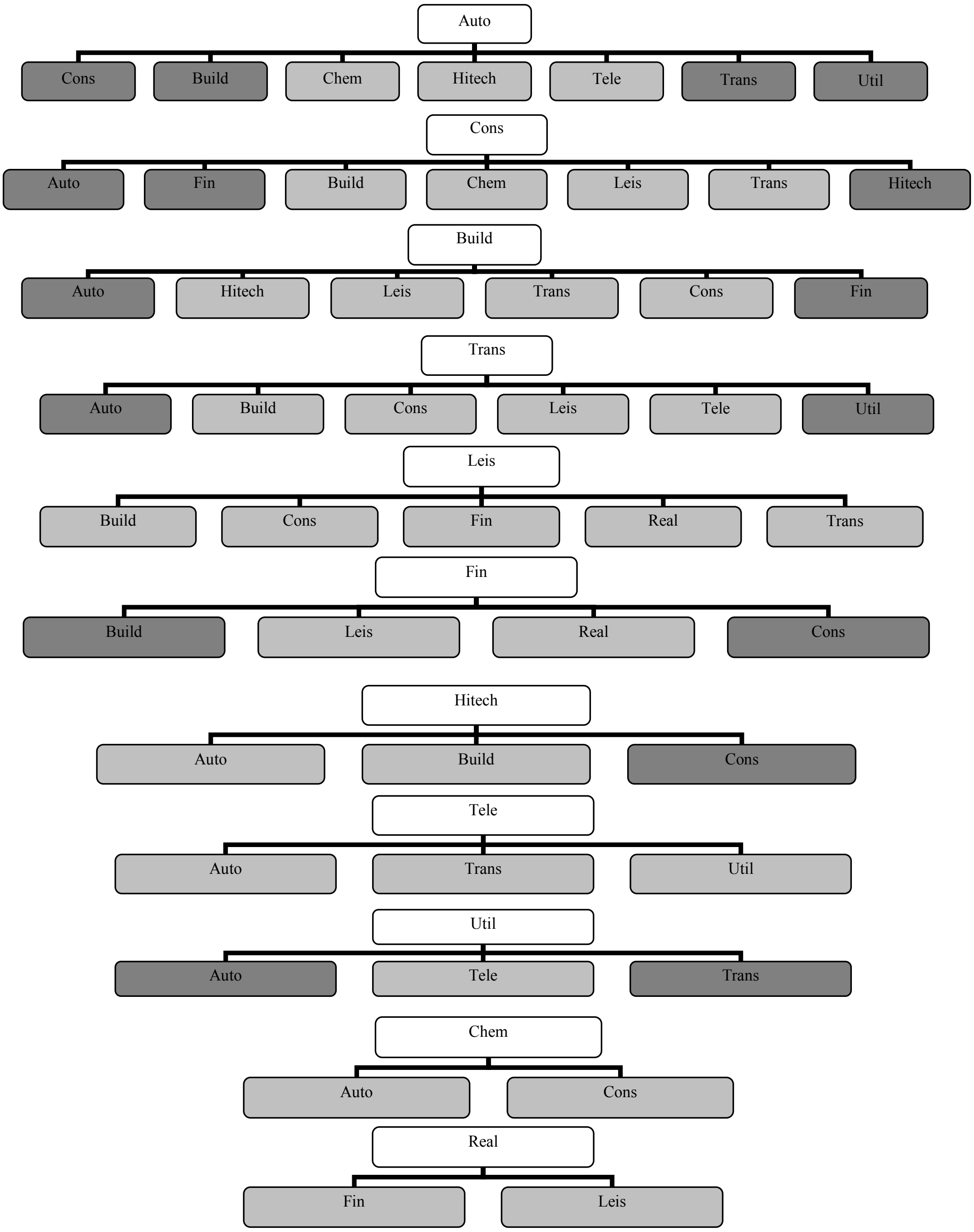


Fig. 1. Inter-industry Default Correlation Charts*

*The white cell represents the industry sector investigated.

Dark-grey represents the industries that are significantly default correlated with the sector investigated at the 0.05 level.

Light-grey represents the industries that are significantly default correlated with the sector investigated at the 0.01 level.

Table 5

Inter-Industry Default Correlations for Recessionary Periods

Correlati

		Aerospa utomotive pita goods/m	Consum ervice	Energy natur resour	Financ instituti	Forest buildi products mebuild	Healt care/c mica	Hig technolo comput office	Insura	Leisu time/me	Real	Teleco unicatio	Transp atio	Utilit
Aerospace/autom pital	Pearson	1.00	.57	.38	.45	.24	.92 *	.68	-	.24	-	.96 **	.08	.62
	P-	.	.31	.52	.43	.69	.02	.20	.61	.69	.75	.00	.88	.26
Consumer/servic	Pearson	.57	1.00	.78	.94 *	.86	.68	.76	.04	.78	.66	.41	.76	.69
	P-	.31	.	.11	.01	.06	.20	.13	.95	.11	.21	.49	.12	.19
Energy and resour	Pearson	.38	.78	1.00	.70	.47	.65	.23	.42	.29	.44	.14	.35	.91 *
	P-	.52	.11	.	.18	.42	.23	.70	.47	.62	.45	.81	.55	.03
Financial	Pearson	.45	.94 *	.70	1.00	.91 *	.50	.77	.26	.83	.67	.28	.76	.65
	P-	.43	.01	.18	.	.03	.38	.12	.66	.08	.20	.64	.13	.23
Forest and products/homeb	Pearson	.24	.86	.47	.91 *	1.00	.25	.79	.05	.97 **	.86	.12	.95 *	.31
	P-	.69	.06	.42	.03	.	.67	.10	.93	.00	.06	.84	.01	.61
Health	Pearson	.92 *	.68	.65	.50	.25	1.00	.53	-	.19	-	.82	.13	.79
	P-	.02	.20	.23	.38	.67	.	.35	.74	.75	.94	.08	.82	.11
Hig technology/compu	Pearson	.68	.76	.23	.77	.79	.53	1.00	-	.84	.40	.65	.69	.29
	P-	.20	.13	.70	.12	.10	.35	.	.62	.07	.49	.22	.19	.62
Insura	Pearson	-	.04	.42	.26	.05	-	-	1.00	-	.11	-	-	.43
	P-	.61	.95	.47	.66	.93	.74	.62	.	.85	.86	.38	.82	.46
Leisure	Pearson	.24	.78	.29	.83	.97 **	.19	.84	-	1.00	.81	.17	.95 *	.14
	P-	.69	.11	.62	.08	.00	.75	.07	.85	.	.09	.77	.01	.81
Real	Pearson	-	.66	.44	.67	.86	-	.40	.11	.81	1.00	-	.93 *	.10
	P-	.75	.21	.45	.20	.06	.94	.49	.86	.09	.	.61	.02	.86
Telecommunic	Pearson	.96 **	.41	.14	.28	.12	.82	.65	-	.17	-	1.00	.01	.40
	P-	.00	.49	.81	.64	.84	.08	.22	.38	.77	.61	.	.97	.49
Transport	Pearson	.08	.76	.35	.76	.95 *	.13	.69	-	.95 *	.93 *	.01	1.00	.10
	P-	.88	.12	.55	.13	.01	.82	.19	.82	.01	.02	.97	.	.87
Utilit	Pearson	.62	.69	.91 *	.65	.31	.79	.29	.43	.14	.10	.40	.10	1.00
	P-	.26	.19	.03	.23	.61	.11	.62	.46	.81	.86	.49	.87	.

*. Correlation is significant at the 0.05.

**. Correlation is significant at the 0.01.

The upper number is the Pearson correlation coefficient, which is the multiple R reported in the linear regression.
The lower number is the P-value associated with the correlation coefficient.

Table 6

Inter-Industry Default Correlations for Expansionary Periods

Correlations

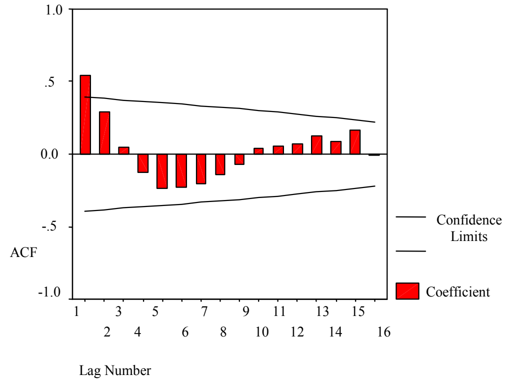
		Aerospace/automotive/capital goods/metal	Consumer/service sector	Energy and natural resources	Financial institutions	Forest and building products/homebuilders	Health care/chemicals	High technology/computers/office equip	Insurance	Leisure time/media	Real estate	Telecommunications	Transportation	Utility
Aerospace/automotive/capital goods/metal	Pearson Correlation	1.000	.249	.429	.054	.575*	.441	.418	-.065	.470*	.061	.626**	.571*	.606**
	P-value	.	.320	.075	.832	.013	.067	.084	.798	.049	.810	.005	.013	.008
Consumer/service sector	Pearson Correlation	.249	1.000	-.404	.130	.604**	.631**	.245	-.089	.286	.036	.290	.520*	.248
	P-value	.320	.	.096	.607	.008	.005	.328	.724	.250	.886	.243	.027	.322
Energy and natural resources	Pearson Correlation	.429	-.404	1.000	-.371	.142	.097	.230	.018	-.125	-.307	-.025	.068	-.005
	P-value	.075	.096	.	.130	.574	.702	.360	.943	.621	.215	.922	.790	.985
Financial institutions	Pearson Correlation	.054	.130	-.371	1.000	-.042	.059	-.055	-.209	.488*	.707**	.013	-.131	.163
	P-value	.832	.607	.130	.	.869	.818	.828	.406	.040	.001	.958	.606	.517
Forest and building products/homebuilders	Pearson Correlation	.575*	.604**	.142	-.042	1.000	.522*	.386	-.143	.450	-.139	.679**	.798**	.694**
	P-value	.013	.008	.574	.869	.	.026	.113	.572	.061	.583	.002	.000	.001
Health care/chemicals	Pearson Correlation	.441	.631**	.097	.059	.522*	1.000	.050	-.052	.353	-.329	.273	.494*	.196
	P-value	.067	.005	.702	.818	.026	.	.844	.839	.150	.182	.273	.037	.435
High technology/computers/office equip	Pearson Correlation	.418	.245	.230	-.055	.386	.050	1.000	-.292	.021	.264	.069	.203	.143
	P-value	.084	.328	.360	.828	.113	.844	.	.240	.934	.289	.787	.418	.572
Insurance	Pearson Correlation	-.065	-.089	.018	-.209	-.143	-.052	-.292	1.000	-.106	-.094	.063	.246	.033
	P-value	.798	.724	.943	.406	.572	.839	.240	.	.677	.709	.804	.325	.898
Leisure time/media	Pearson Correlation	.470*	.286	-.125	.488*	.450	.353	.021	-.106	1.000	.394	.356	.581*	.396
	P-value	.049	.250	.621	.040	.061	.150	.934	.677	.	.106	.147	.011	.103
Real estate	Pearson Correlation	.061	.036	-.307	.707**	-.139	-.329	.264	-.094	.394	1.000	-.122	-.149	.045
	P-value	.810	.886	.215	.001	.583	.182	.289	.709	.106	.	.629	.556	.858
Telecommunications	Pearson Correlation	.626**	.290	-.025	.013	.679**	.273	.069	.063	.356	-.122	1.000	.675**	.947**
	P-value	.005	.243	.922	.958	.002	.273	.787	.804	.147	.629	.	.002	.000
Transportation	Pearson Correlation	.571*	.520*	.068	-.131	.798**	.494*	.203	.246	.581*	-.149	.675**	1.000	.581*
	P-value	.013	.027	.790	.606	.000	.037	.418	.325	.011	.556	.002	.	.011
Utility	Pearson Correlation	.606**	.248	-.005	.163	.694**	.196	.143	.033	.396	.045	.947**	.581*	1.000
	P-value	.008	.322	.985	.517	.001	.435	.572	.898	.103	.858	.000	.011	.

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

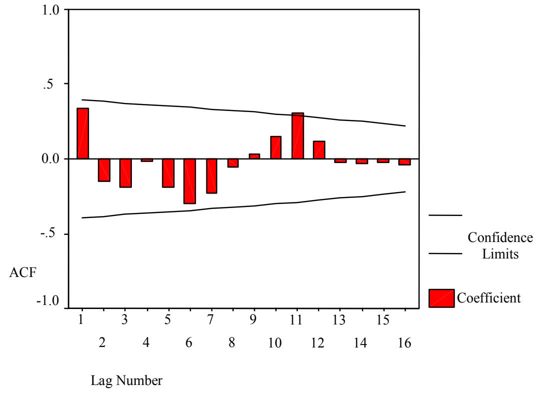
The upper number is the Pearson correlation coefficient, which is the multiple R reported in linear regression.
The lower number is the P-value associated with the correlation coefficient.

Aerospace/automotive/capital goods/metal



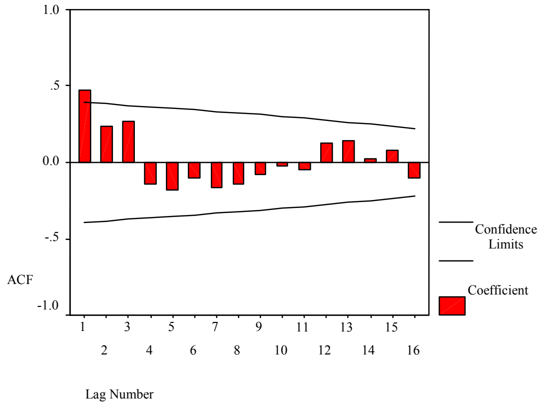
*Autocorrelation is present at the 1st lag.

Forest and building products/homebuilders



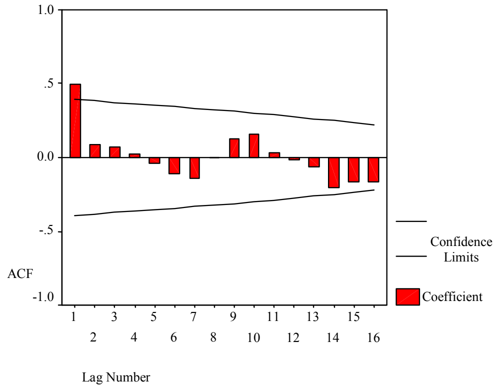
*Autocorrelation is present at the 11th lag.

Health care/chemicals



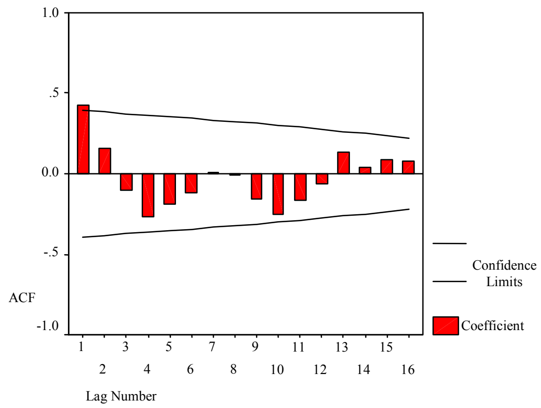
*Autocorrelation is present at the 1st lag.

Consumer/service sector



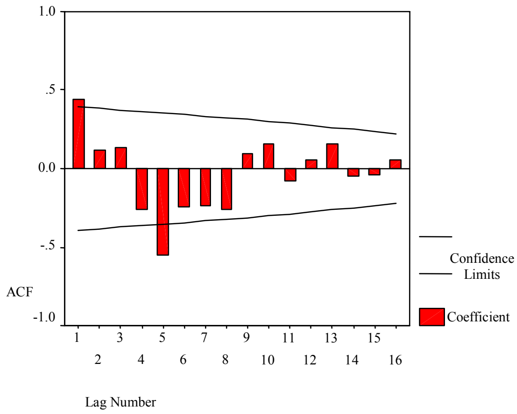
*Autocorrelation is present at the 1st lag.

Energy and natural resources

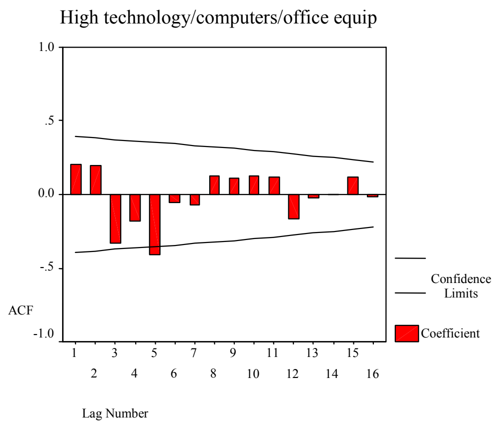


*Autocorrelation is present at the 1st.

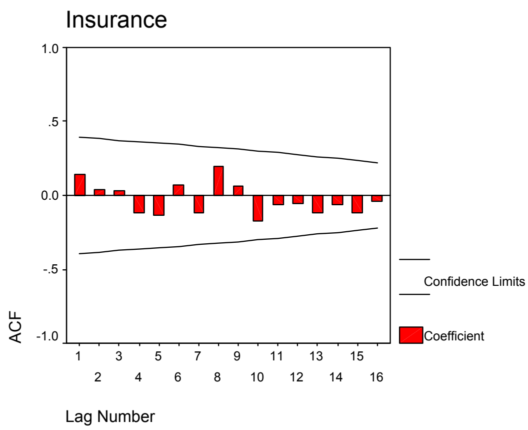
Financial institutions



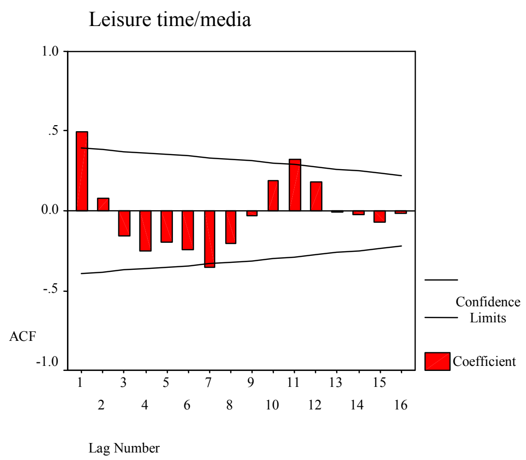
*Autocorrelation is present at the 1st and the 5th lag.



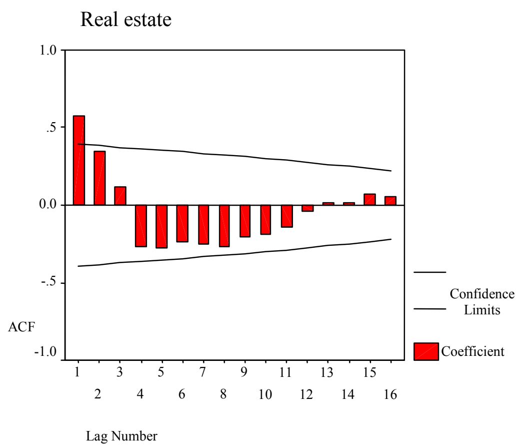
*Autocorrelation is present at the 5th lag



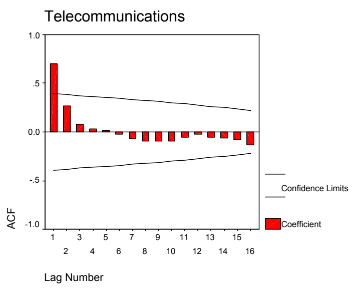
*Autocorrelation is not present (red bars stay within the two confidence interval lines)



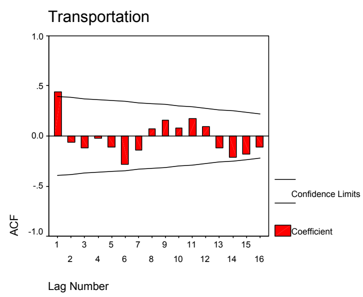
*Autocorrelation is present at the 1st, 7th and 11th lags.



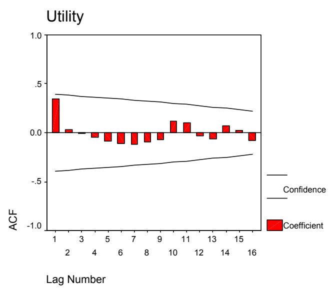
*Autocorrelation is present at the 1st lag.



*Autocorrelation is present at the 1st lag.



*Autocorrelation is present at the 1st lag.



*Autocorrelation is not present.

Fig. 2. Intra-Industry Default Correlations (SPSS automatically uses 16 lagged values as the default)

Table 7

Regression Analyses

Original Regression Equation: $Y_t = \alpha + \beta_1 RSP500_t + \beta_2 RTNX_t + \beta_3 RGDP_t + \epsilon_t$,
where

$t = 1, 2, \ldots, T$ observations
Y_t = default rate per industry
$RSP500_t$ = the return of the S&P 500 index
$RTNX_t$ = the return of the 10 year treasury yield index
$RGDP_t$ = the return of the gross domestic product
α = the intercept of the equation
$\beta_1, \ldots, \beta_3$ = the slope coefficients for each of the independent variable
ϵ_t = the error term, which represents the portion of the dependent variable that cannot be explained by the independent variables

Consumer/service sector:

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.649[a]	.421	.329	1.51523E-02

a. Predictors: (Constant), RGDP, RSP500, RTNX

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	P-value
1	Regression	3.167E-03	3	1.056E-03	4.599	.014[a]
	Residual	4.362E-03	19	2.296E-04		
	Total	7.530E-03	22			

a. Predictors: (Constant), RGDP, RSP500, RTNX
b. Dependent Variable: CONS

Multiple R is the correlation between the actual values of Y and the forecast values of Y.

R Square is the square of multiple R, also called the coefficient of determination, which measures the fraction of the total variance in the dependent variable that is explained by the independent variables.

Std. Error of the Estimate measures the standard deviation of ϵ_t, the residual term in the regression.

The Regression Sum of Squares is the amount of total variation in Y that is explained in the regression equation.

The Regression degree of freedom (df) is the number of slope parameters estimated (in this case, three).

The Regression Mean Square is computed by dividing the regression sum of squares by the regression df.

The Residual Sum of Squares is the total of squared ϵ_t, the residual term in the regression.

The Residual Degree of Freedom (df) is the number of observations, n, minus the total number of parameters estimated (in this case, four).

The Residual Mean Square is computed by dividing the residual sum of squares by the residual df.

The F-statistic tests whether all the slope coefficients in a linear regression are equal to 0, and measures how well the regression equation explains the variation in the dependent variable, which is equal to the regression mean square dividing the residual mean square.

The P-value indicates the overall model's significance. Because the P-value is below 0.05, the regression model is statistically significant beyond the 0.05 level.

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	P-value
		B	Std. Error	Beta		
1	(Constant)	6.036E-02	.011		5.585	.000
	RSP500	-1.28E-02	.021	-.105	-.599	.557
	RTNX	-4.56E-04	.018	-.005	-.026	.980
	RGDP	-.575	.165	-.644	-3.480	.003

a. Dependent Variable: CONS

This table examines each individual independent variable to see if it significantly influences the dependent variable.

Beta is the reported slope coefficient for each independent variable.

Std. Error measures the standard deviation of each parameter estimated (constant and slope coefficients).

The T-statistic tests whether the estimated values of the intercept and slope coefficients are equal to 0.

The P-value indicates the statistical significance of each of the estimated coefficients. Besides the intercept, the return to GDP (RGDP) significantly influences the default rates in Consumer/service sector ('Cons') beyond the 0.01 level.

New Regression Equation: $Y_t = \alpha + \beta RGDP_t + \epsilon_t$

where the nonsignificant independent variables $RSP500_t$ and $RTNX_t$ are removed, and the equation is reestimated using only significant relationships to generate unbiased estimates for coefficients.

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.640[a]	.410	.382	1.45486E-02

a. Predictors: (Constant), RGDP

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	P-value
1	Regression	3.085E-03	1	3.085E-03	14.574	.001[a]
	Residual	4.445E-03	21	2.117E-04		
	Total	7.530E-03	22			

a. Predictors: (Constant), RGDP
b. Dependent Variable: CONS

P-value is below 0.01, hence overall regression model is statistically significant beyond the 0.01 level.

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	P-value
		B	Std. Error	Beta		
1	(Constant)	5.901E-02	.009		6.263	.000
	RGDP	-.571	.150	-.640	-3.818	.001

a. Dependent Variable: CONS

The return to GDP significantly influences the default rates in Consumer/service sector ('Cons') beyond the 0.01 level.

Forest and building products/homebuilders:

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.635[a]	.403	.308	1.97913E-02

a. Predictors: (Constant), RTNX, RSP500, RGDP

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	P-value
1	Regression	5.017E-03	3	1.672E-03	4.270	.018[a]
	Residual	7.442E-03	19	3.917E-04		
	Total	1.246E-03	22			

a. Predictors: (Constant), RTNX, RSP500, RGDP
b. Dependent Variable: BUILD

P-value is below 0.05, hence overall regression model is statistically significant beyond the 0.05 level.

The P-value indicates that besides the intercept, the return to GDP (RGDP) significantly influences the default rates in Forest and building products/homebuilders sector ('Build') beyond the 0.05 level.

New Regression Equation: $Y_t = \alpha + \beta RGDP_t + \epsilon_t$

where the nonsignificant independent variables $RSP500_t$ and $RTNX_t$ are removed, and the equation is reestimated using only significant relationships to generate unbiased estimates for coefficients.

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.513[a]	.263	.228	2.09058E-02

a. Predictors: (Constant), RGDP

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	P-value
1	Regression	3.282E-03	1	3.282E-03	7.508	.012[a]
	Residual	9.178E-03	21	4.371E-04		
	Total	1.246E-03	22			

a. Predictors: (Constant), RGDP
b. Dependent Variable: BUILD

P-value is below 0.05, hence overall regression model is statistically significant beyond the 0.05 level.

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	P-value
		B	Std. Error	Beta		
1	(Constant)	5.531E-02	.014		4.086	.001
	RGDP	-.589	.215	-.513	-2.740	.012

a. Dependent Variable: BUILD

The return to GDP significantly influences the default rates in Forest and building products/homebuilders sector ('Build') beyond the 0.05 level.

Telecommunications:

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.693[a]	.480	.397	3.58240E-02

a. Predictors: (Constant), RGDP, RSP500, RTNX

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	P-value
1	Regression	2.247E-02	3	7.491E-03	5.837	.005[a]
	Residual	2.438E-02	19	1.283E-04		
	Total	4.686E-02	22			

a. Predictors: (Constant), RGDP, RSP500, RTNX
b. Dependent Variable: TELE

P-value is below 0.01, hence overall regression model is statistically significant beyond the 0.01 level.

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	P-value
		B	Std. Error	Beta		
1	(Constant)	9.845E-02	.026		3.853	.001
	RSP500	-.165	.050	-.546	-3.274	.004
	RTNX	-9.13E-04	.042	-.004	-.022	.983
	RGDP	-1.011	.390	-.454	-2.590	.018

a. Dependent Variable: TELE

The P-value indicates that besides the intercept, the returns to S&P 500 (RSP500) and GDP (RGDP) significantly influence the default rates in Telecommunications sector ('Tele') respectively beyond the 0.01 level and 0.05 level.

New Regression Equation: $Y_t = \alpha + \beta_1 RSP500_t + \beta_2 RGDP_t + \epsilon_t$

where the nonsignificant independent variable $RTNX_t$ is removed, and the equation is re-estimated using only significant relationships to generate unbiased estimates for coefficients.

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.693[a]	.480	.428	3.49173E-02

a. Predictors: (Constant), RGDP, RSP500

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	P-value
1	Regression	2.247E-02	2	1.124E-02	9.216	.001[a]
	Residual	2.438E-02	20	1.219E-03		
	Total	4.686E-02	22			

a. Predictors: (Constant), RGDP, RSP500
b. Dependent Variable: TELE

P-value is below 0.01, hence overall regression model is statistically significant beyond the 0.01 level.

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	P-value
		B	Std. Error	Beta		
1	(Constant)	9.865E-02	.023		4.236	.000
	RSP500	-.165	.049	-.546	-3.378	.003
	RGDP	-1.014	.360	-.455	-2.820	.011

a. Dependent Variable: TELE

.The returns to S&P 500 (RSP500) and GDP (RGDP) significantly influence the default rates in Telecommunications sector ('Tele') respectively beyond the 0.01 level and 0.05 level.

Utility:

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.625[a]	.390	.294	8.09824E-03

a. Predictors: (Constant), RTNX, RSP500, RGDP

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	P-value
1	Regression	7.983E-04	3	2.661E-04	4.058	.022[a]
	Residual	1.246E-03	19	6.558E-05		
	Total	2.044E-03	22			

a. Predictors: (Constant), RTNX, RSP500, RGDP
b. Dependent Variable: UTIL

P-value is below 0.05, hence overall regression model is statistically significant beyond the 0.05 level.

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	P-value
		B	Std. Error	Beta		
1	(Constant)	1.700E-02	.006		2.944	.008
	RSP500	-3.18E-02	.011	-.503	-2.787	.012
	RGDP	-.165	.088	-.355	-.657	.077
	RTNX	-6.22E-03	.009	-.126		.519

a. Dependent Variable: UTIL

The P-value indicates the return to S&P 500 (RSP500) significantly influences the default rates in Utility sector ('Util') beyond the 0.05 level.

New Regression Equation: $Y_t = \alpha + \beta RSP500_t + \epsilon_t$

where the nonsignificant independent variables $RTNX_t$ and $RGDP_t$ are removed, and the equation is reestimated using only significant relationships to generate unbiased estimates for coefficients.

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.470[a]	.220	.183	8.71138E-03

a. Predictors: (Constant), RSP500

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	P-value
1	Regression	4.507E-04	1	4.507E-04	5.939	.024[a]
	Residual	1.594E-03	21	7.589E-05		
	Total	2.044E-03	22			

a. Predictors: (Constant), RSP500
b. Dependent Variable: UTIL

P-value is below 0.05, hence overall regression model is statistically significant beyond the 0.05 level.

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	P-value
		B	Std. Error	Beta		
1	(Constant)	7.262E-03	.002		3.408	.003
	RSP500	-2.97E-02	.012	-.470	-2.437	.024

a. Dependent Variable: UTIL

The return to S&P 500 (RSP500) significantly influences the default rates in Utility sector ('Util') beyond the 0.05 level.

Table 8

Industry Equity Index Return Correlations

Correlations

		Energy equity index return	Financials equity index return	Building products equity index return	Health care equity index return	Technology equity index return	Insurance equity index return	Telecommunications equity index return	Utility equity index return
Energy equity index return	Pearson Correlation	1.000	.568**	.496**	.470**	.447*	.541**	.583**	.689**
	P-value	.	.001	.005	.009	.013	.002	.001	.000
Financials equity index return	Pearson Correlation	.568**	1.000	.677**	.642**	.808**	.888**	.751**	.684**
	P-value	.001	.	.000	.000	.000	.000	.000	.000
Building products equity index return	Pearson Correlation	.496**	.677**	1.000	.244	.498**	.609**	.417*	.568**
	P-value	.005	.000	.	.194	.005	.000	.022	.001
Health care equity index return	Pearson Correlation	.470**	.642**	.244	1.000	.642**	.633**	.766**	.506**
	P-value	.009	.000	.194	.	.000	.000	.000	.004
Technology equity index return	Pearson Correlation	.447*	.808**	.498**	.642**	1.000	.640**	.787**	.454*
	P-value	.013	.000	.005	.000	.	.000	.000	.012
Insurance equity index return	Pearson Correlation	.541**	.888**	.609**	.633**	.640**	1.000	.697**	.543**
	P-value	.002	.000	.000	.000	.000	.	.000	.002
Telecommunications equity index return	Pearson Correlation	.583**	.751**	.417*	.766**	.787**	.697**	1.000	.475**
	P-value	.001	.000	.022	.000	.000	.000	.	.008
Utility equity index return	Pearson Correlation	.689**	.684**	.568**	.506**	.454*	.543**	.475**	1.000
	P-value	.000	.000	.001	.004	.012	.002	.008	.

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

The upper number is the Pearson correlation coefficient, which is the multiple R reported in linear regression.

The lower number is the P-value associated with the correlation coefficient.